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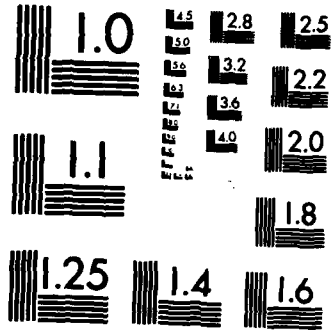

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REPORT NO. T3/84

A RODENT WATER DISPENSING SYSTEM FOR USE IN HYPOBARIC CHAMBERS

US ARMY RESEARCH INSTITUTE
OF
ENVIRONMENTAL MEDICINE
Natick, Massachusetts

MARCH 1984

UNITED STATES ARMY
MEDICAL RESEARCH & DEVELOPMENT COMMAND

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) A water dispensing system for rodents has been developed for use in chronic research studies involving hypobaric chambers. The system removes an existing problem that has restricted long-term animal exposures due to limitations inherent in the typical water supply bottles. The bottle design used in previous systems makes it susceptible to leakage whenever the water surface tension is disturbed. This disturbance occurs when water or room temperatures change, when animals are drinking, or more dramatically when the barometric pressure changes during ascents to altitude. Exposed water on the chamber floor may produce secondary health and

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envitonmental concerns. Daily returns to sea level to replenish drinking water and clean the chamber become the only available solution but add a complicating research variable. With the present water dispensing system, water may be replenished on-line for indefinite operations; water is available to rodent ad libitum, independent of the pressure differential without leakage; the system is insensitive to water pressure and malfunctions to mineral deposits; the amount of water consumed can be measured; and medications, drug, and vitamins may be administered.

Abstract

A water dispensing system for rodents has been developed for use in chronic research studies involving hypobaric chambers. The system removes an existing problem that has restricted long-term animal exposures due to limitations inherent in the typical water supply bottles. The bottle design used in previous systems makes it susceptible to leakage whenever the water surface tension is disturbed. This disturbance occurs when water or room temperatures change, when animals are drinking, or more dramatically when the barometric pressure changes during ascents to altitude. Exposed water on the chamber floor may produce secondary health and environmental concerns. Daily returns to sea level to replenish drinking water and clean the chamber become the only available solution but add a complicating research variable. With the present water dispensing system, water may be replenished on-line for indefinite operations; water is available to rodent ad libitum, independent of the pressure differential without leakage; the system is insensitive to water pressure and malfunctions due to mineral deposits; the amount of water consumed can be measured; and medications, drugs and vitamins may be administered.

INTRODUCTION

One of the single most critical factors in limiting chronic hypobaric research studies with rodents is the limitations inherent in the typical water supply bottles. A rodent water dispensing bottle cannot be inverted without spillage. Additional water loss occurs when the air expands inside the bottle as water warms up to room temperatures or from temperature variations in the room itself. The reason is traceable to the bottle design where static pressure at the nozzle holds the water inside. This external pressure is in delicate balance with the negative pressure of the air space at the top of the fluid. A small disturbance can disrupt this surface tension equilibrium resulting in water loss. This happens when the bottle is jarred, the animal breaks the surface tension when drinking and/or the ambient barometric pressure changes with sufficient amplitude. The latter problem is magnified when water bottles are used for animal research studies conducted at low barometric pressure in hypobaric chambers. Large amounts of water are lost when the air pocket at the top of the bottle expands (increased volume) as the air pressure around the bottle decreases during ascents to altitude. Water loss also occurs due to minor oscillations under the finest of pressure control($\pm$ 1 mmHg) and could account for significant losses when coupled with other disturbances such as animal feeding and nocturnal activities.

Exposed water on the chamber floor induces secondary health and environmental concerns and adds to the difficulties of conducting chronic

simulated altitude research studies. Daily returns to sea level to replenish drinking water and to clean the chamber become the only available solution but add a complicating variable.

In view of the water bottle limitations as described above, the automatic water drinking system represents a significant technological breakthrough. In removing the long-time problem that restricted chronic research studies, the water-dispensing system represents the following achievements: water may be replenished on-line for indefinite operations; water is available to the rodent ad libitum independent of the pressure differential without leakage; the system is insensitive to water pressure and malfunctions due to mineral deposits the amount of water consumed can be measured and medications, drugs and vitamins may be administered. The following text will explain the technological aspects of those achievements.

SYSTEM DESCRIPTION

The water supply container (Travenol Intravenous Bottle, I.V.) is located externally to the hypobaric simulator so replacement units may be installed without interrupting an ongoing study (Fig. 1). Toggle shut-off supply and vent (equalizing) valves isolate the bottle from the facility during replacement. It is possible to estimate animal water consumption because the bottle is graduated (0-1000 ml, in increments of 50 ml). Water is gravity-fed because the vent line equalizes the air space above

the fluid with the chamber pressure. The tubing (Imperial Eastman, Type 44P, Poly-flo) is not subject to embrittlement or swelling, has excellent resistance to flexural fatigue and can withstand a 200 psi pressure.

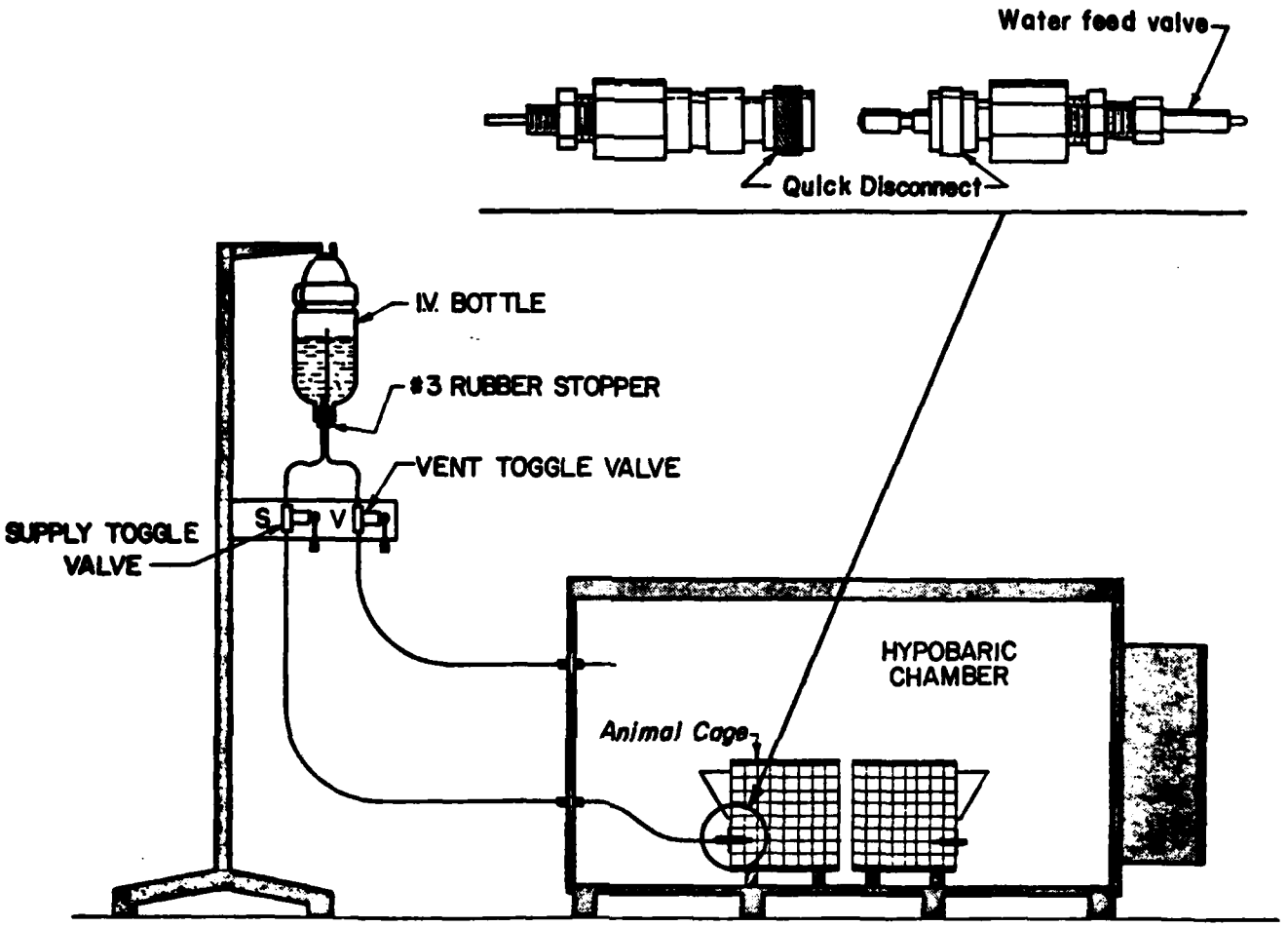
Bulkhead liquid/air tight connectors (Lapp, Model SL-7) provide uninterrupted feed-through for the poly-flow tubing (Fig. 2). A neoprene compression gland fits tightly around the tubing and effects a seal when the domed nut is threaded over the top of the tapered (collet) sleeve. The collet design accommodates various size tubing (.90 in - .265 in).

An automatic pivoting stem drinking valve (Edstrom, Model PV1035T) dispenses fluid to the rodent on demand (Fig. 3). When the animal drinks, the stem pivots on one side of its head which allows the other side to lift off the "O" ring and flex the diaphragm. Water then flows from the supply line, through the center of the "O" ring to the animal. As soon as the stem is released, the diaphragm closes the valve, stopping the flow of water. Since the stem pivots, it is like the use of a lever for lifting a heavy load. This allows a greater force to be exerted against the seal and yet little effort is required by the animal to obtain water. The entire system is insensitive to pressure changes since the valve may be operated with pressure differentials as high as 60 psi or as a gravity feed line. The drinking valve is connected to the animal cage with a Swagelock (Series "QC") quick-connect fitting. The automatic double-end shut-off minimizes pressure loss and fluid spillage during the push or pull operation used to connect or disconnect units. The quick-connect

fitting allows the cages to be removed for cleaning without loss of water from the system.

CONCLUSION

The water dispensing system for rodents in hypobaric chambers provides the potential for a no-loss infinite supply of water, permitting uninterrupted chronic research studies in hypobaric facilities. Other undesirable health and environmental problems caused by uncontrolled water losses have been eliminated. Water is available to the animal ad libitum, and there is no loss due to water or atmospheric pressure differentials. Cleaner cages, a cleaner chamber interior, a means of estimating water consumption, and the administration of medications are additional virtues of the water dispensing system.



WATER DISPENSING SYSTEM
FOR RODENTS IN HYPOBARIC SIMULATOR

Fig. 1. Composite view of the water dispensing system with magnified view of the quick disconnect fitting containing the water feed valve.

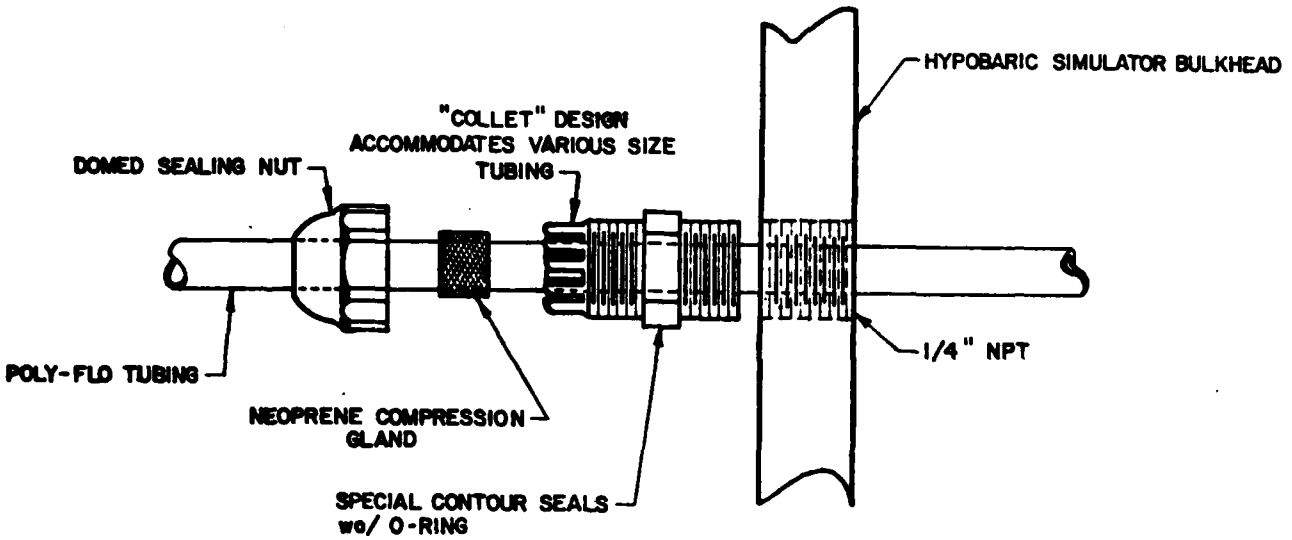
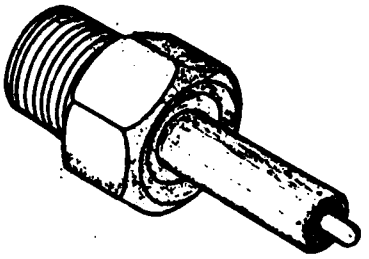
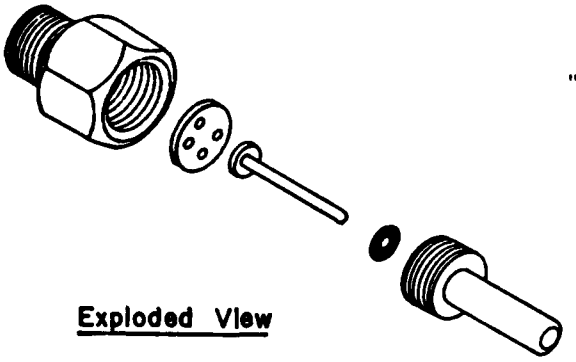


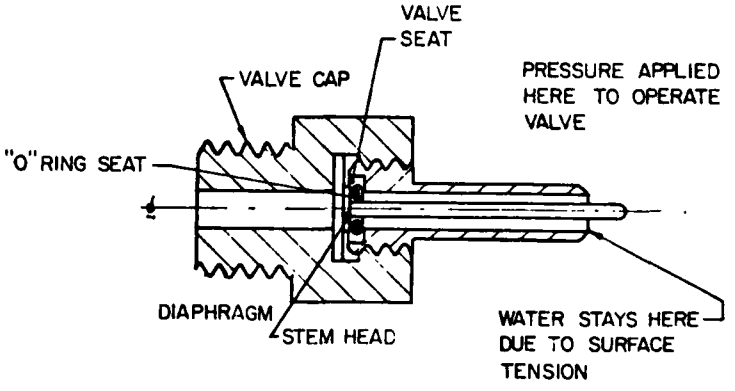
Fig. 2. Exploded view of the air-tight bulkhead connector used as a feed-through for the water supply tubing.



PIVOTING STEM DRINKING VALVE



Exploded View



Cross Section

Fig. 3. Exploded and cross sectional views of the pivoting stem drinking valve.

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